From Super-Earths to Giant Planets.

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Stéphane Udry and the HARPS team

Unbiased exoplanet populations from the HARPS surveys

250 nights on the 3.6 m at La Silla (HARPS GTO Mayor et al.)
+
280 additional nights ,continuation of that survey (Udry et al.)

An updated version of :
Mayor, Marmier, Lovis et al. 2011

Stellar sample

CORALIE volume-limited sample:

- distance < 50 pc
- log R'HK < -4.75 (F,G); -4.70 (K)
- no binaries
- measurement precision ~5 m/s

822 FGK stars (1998 to present)

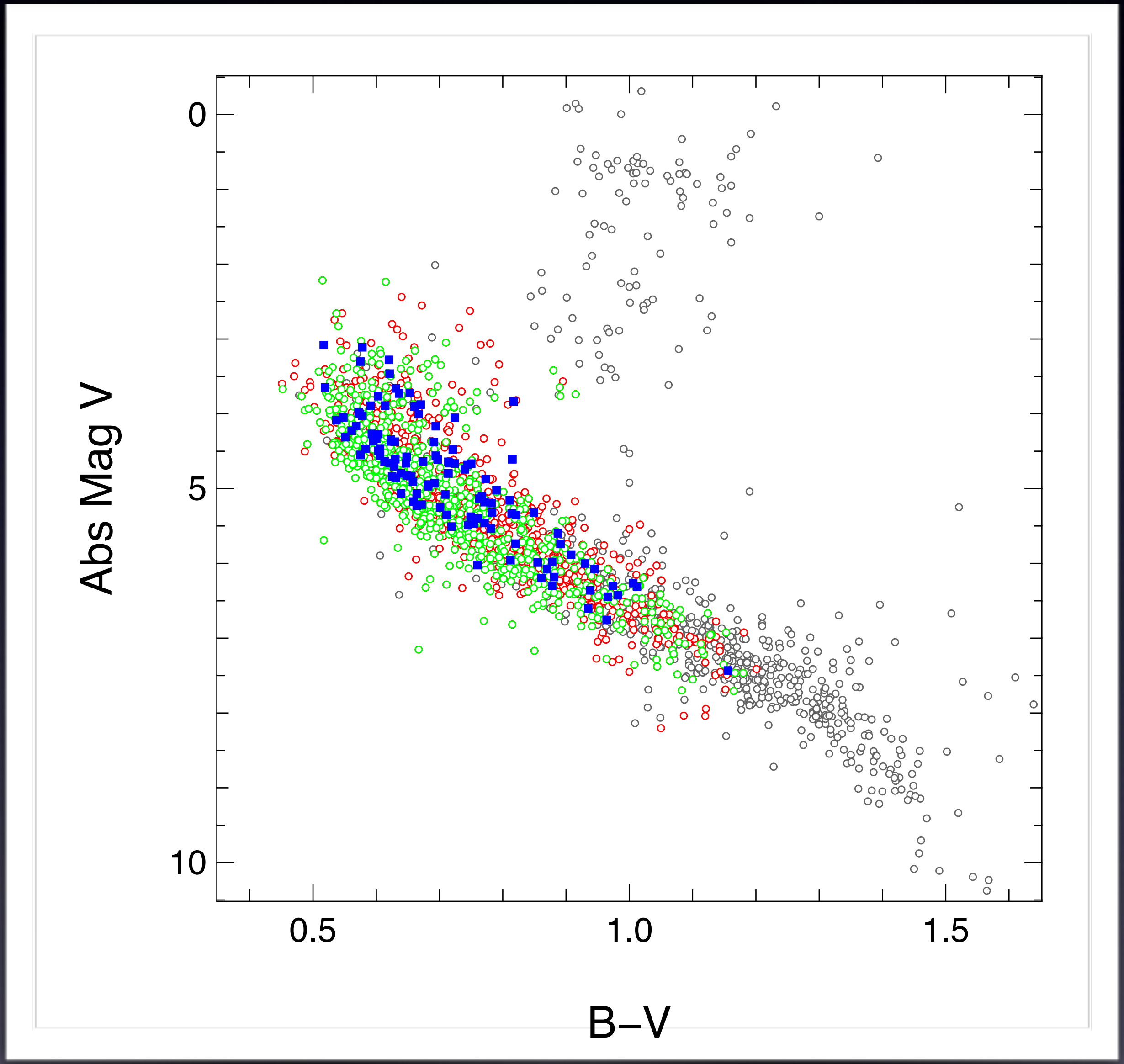
Focus on gaseous giant planets, long periods

HARPS subsample:

- measurement precision ~0.5 m/s

376 FGK stars (2003 to present)

Focus on super-Earths and Neptune-mass planets



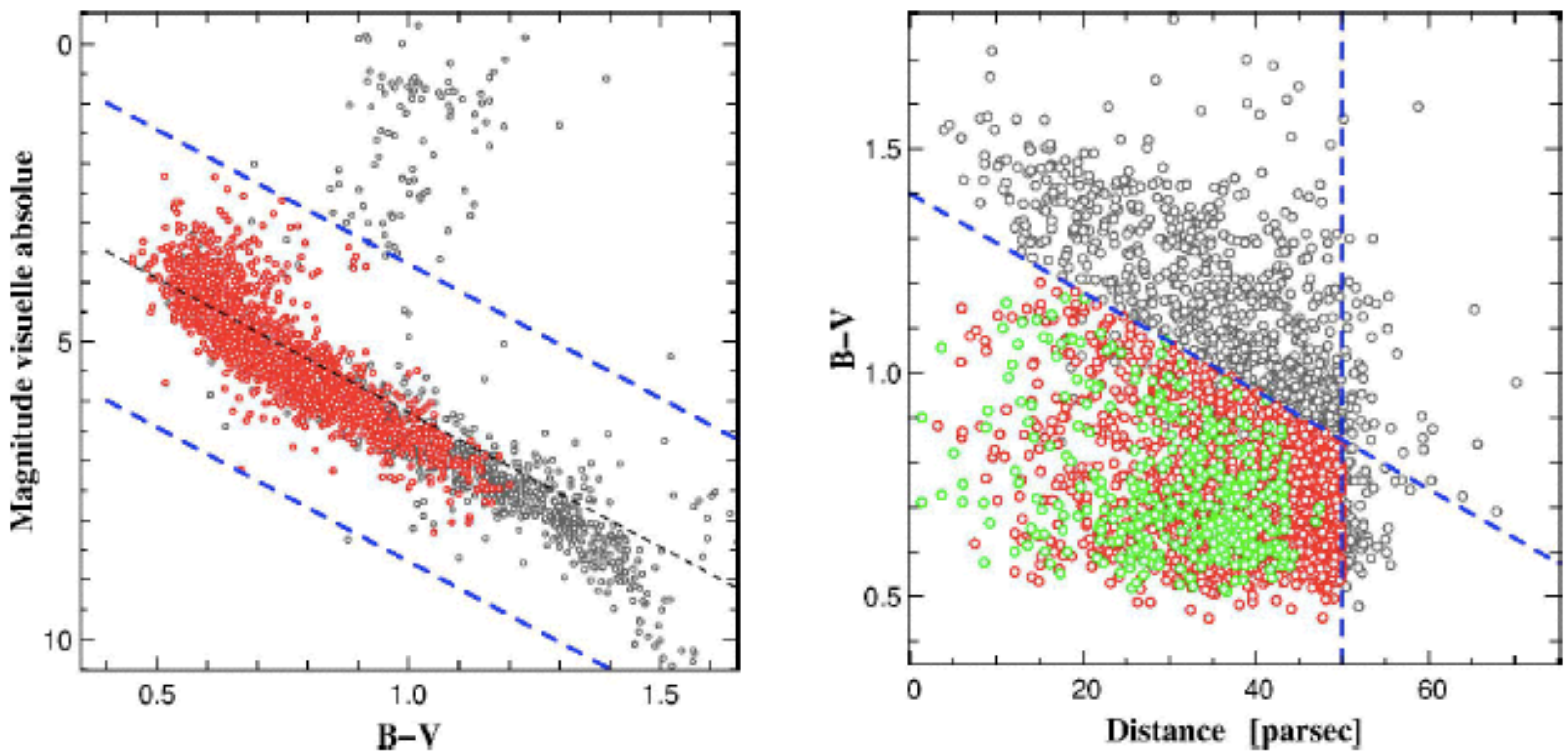


FIGURE 3.3 – Sélection de l'échantillon CORALIE. Les cibles Hipparcos de type spectraux F8 à M0 situées à moins de 50 pc du Soleil dans l'hémisphère sud et ayant une précision $\sigma_\pi \leq 5$ mas sont représentées en gris. Deux critères de sélection supplémentaires ont été utilisés pour la définition de l'échantillon CORALIE (en rouge). Une limite photométrique à 2.5 magnitudes de la séquence principale (à gauche) permet d'éliminer les géantes alors qu'une distance maximale fonction de la couleur permet d'écarter les étoiles tardives n'ayant pas un flux suffisant (à droite). Les cibles marquées en vert appartiennent également au programme HARPS (c.f. sect. 3.2).

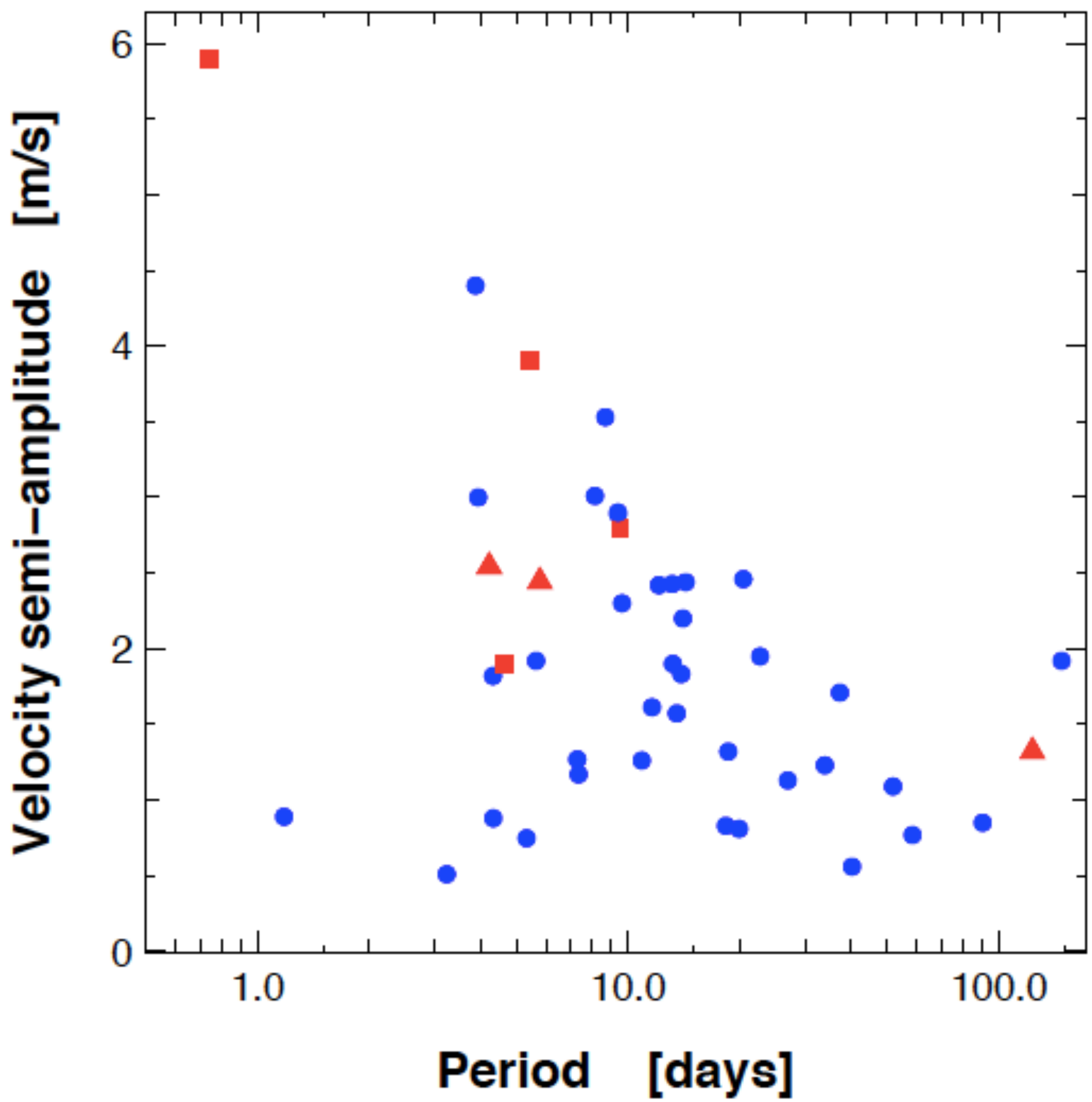


Fig. 2. Radial-velocity semi-amplitude K as a function of orbital period for super-Earths ($M < 10\,M_{\oplus}$) hosted by solar-type stars. HARPS detection are plotted as blue dots and objects from the literature in red symbols (triangles for the southern sky and squares for the northern sky).

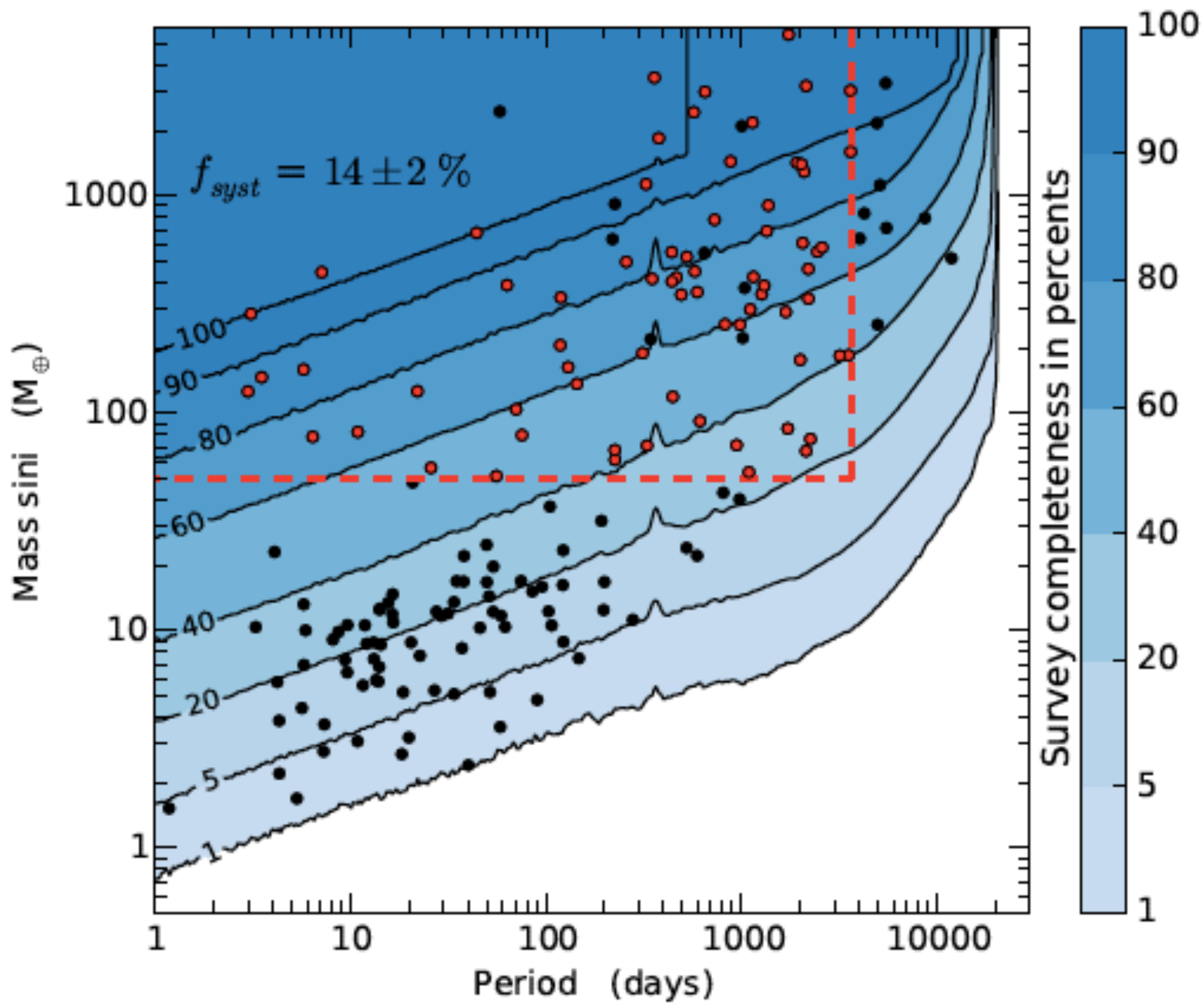
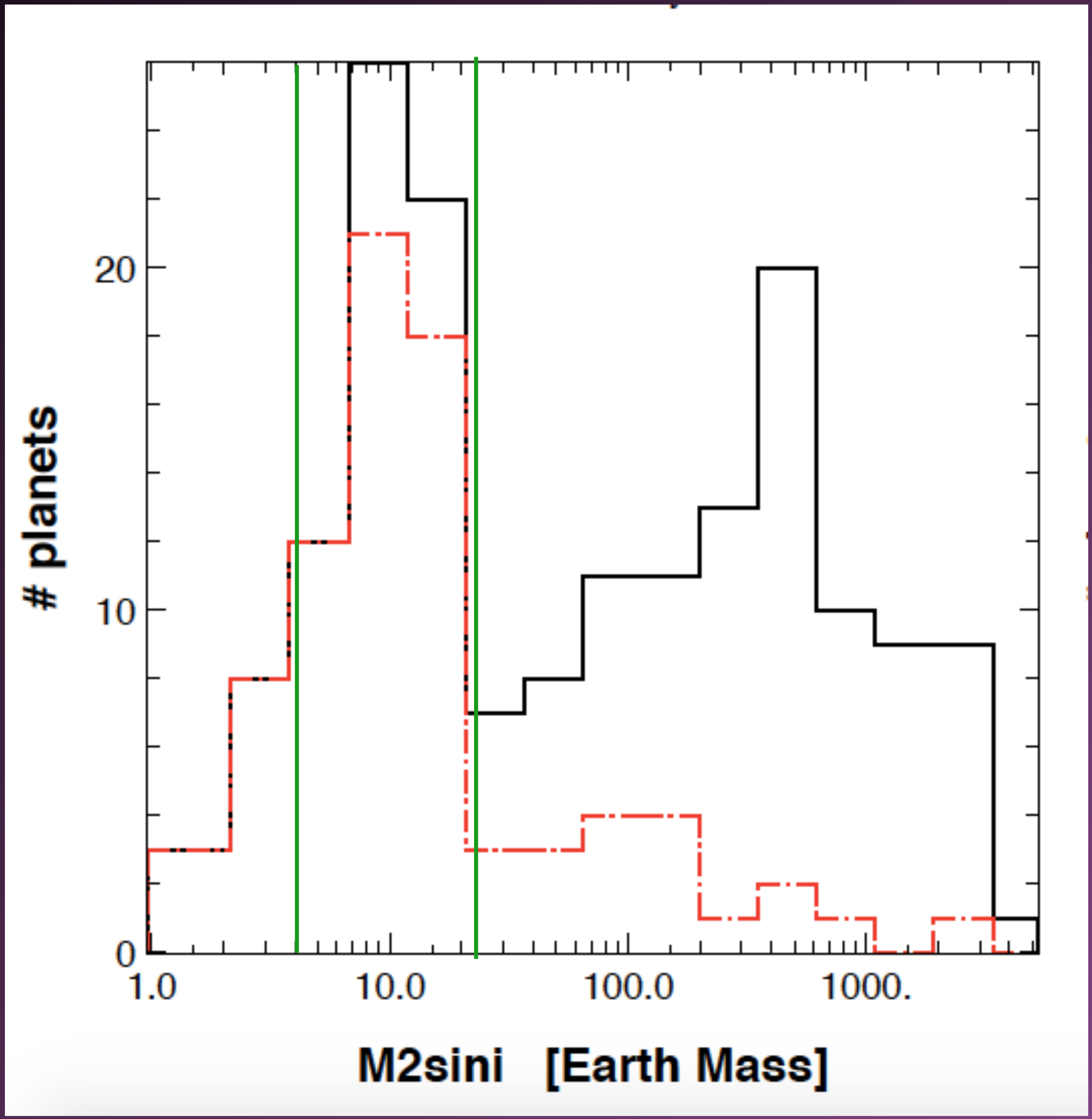
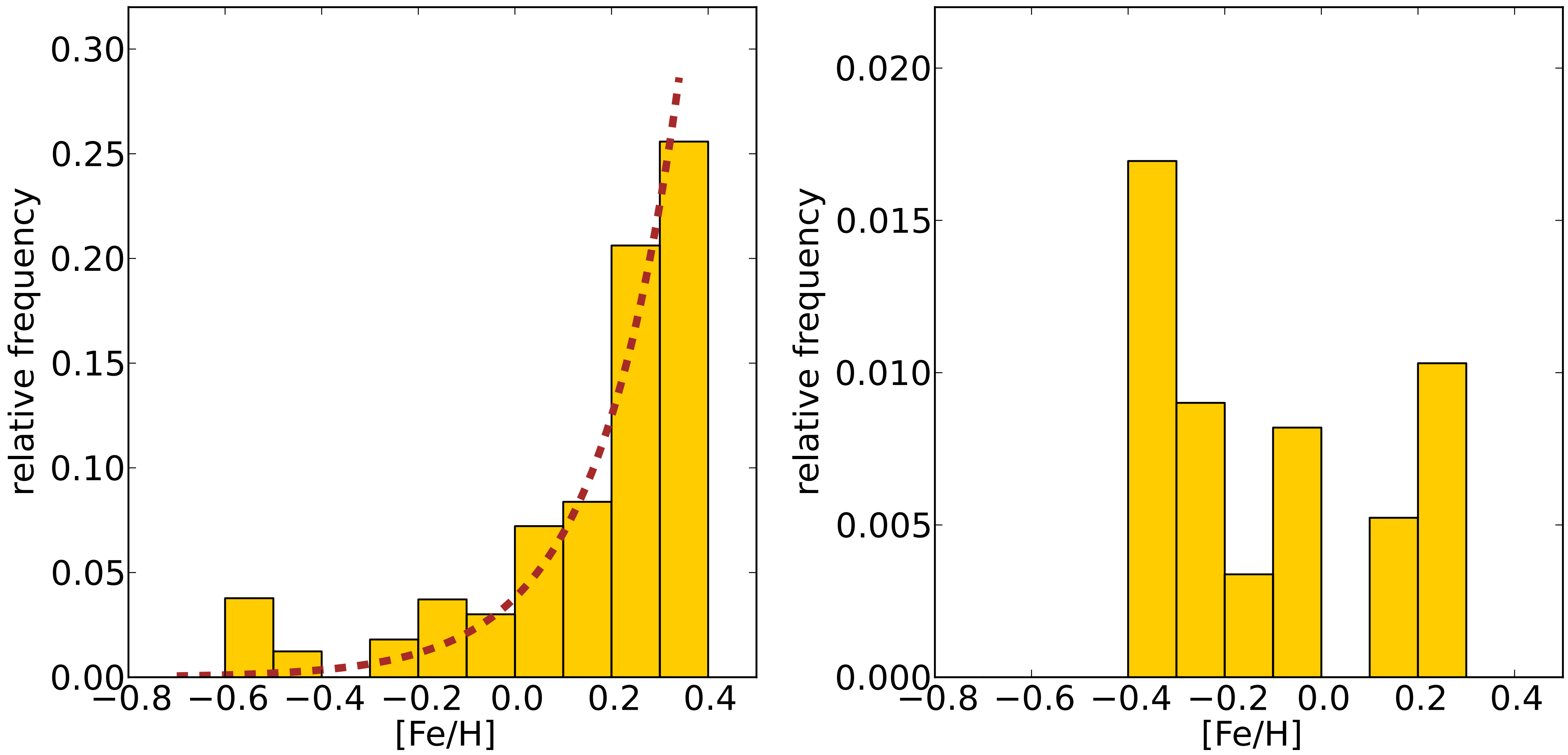


Fig. 5. Plot of the 169 planets of the considered HARPS+CORALIE sample in the $m_2 \sin i - \log P$ plane. The superimposed curves indicate the completeness of the survey. These detection probabilities are valid for the whole sample of 822 stars. After correcting for the detection bias, the fraction of stars with at least one planet more massive than 50 $M_\oplus$ and with a period smaller than 10 years is estimated to be $14 \pm 2\,\%$. The red points represent the planets which have been used to compute the corrected occurrence rate in the box indicated by the dash-dotted line. (Only one planet is taken account per system). The planets lying outside the box or being part of a system already taken into account are excluded; they are shown in black.



20
10
0
1.0
10.0
100.0
1000.
planets
M2sini [Earth Mass]

A drastic difference of the occurence of planets
as a function of stellar metallicity and planetary mass.

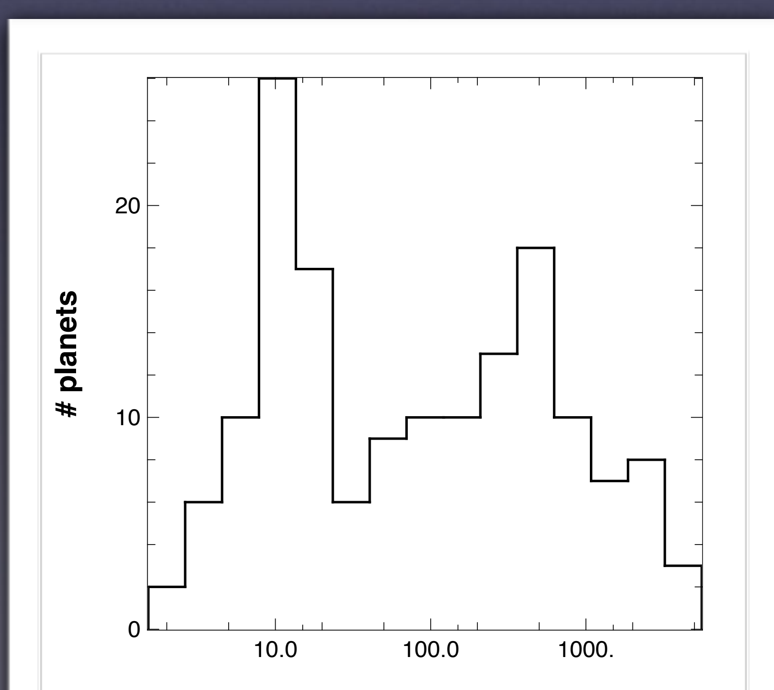


Two planetary populations with distinct properties
(and well separated in the mass histogramme)

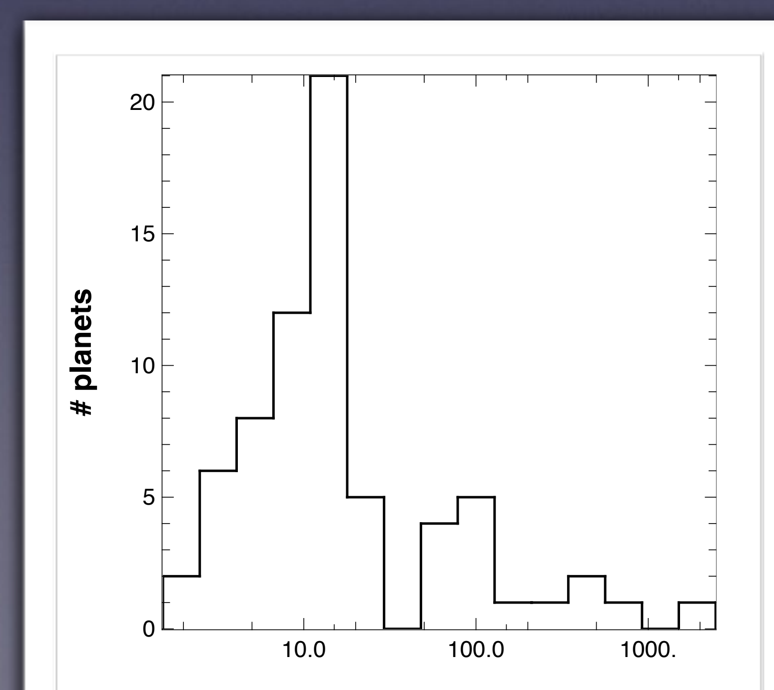
Planetary systems with all masses smaller than 30 Mearth
Multiplicity > 70 %
Frequency not correlated with Fe/H
Frequency decreasing with log P

Planetary systems with gaseous giant planets
(Multiplicity of about 25% ?)
Frequency strongly correlated with Fe/H
Frequency increasing with log P

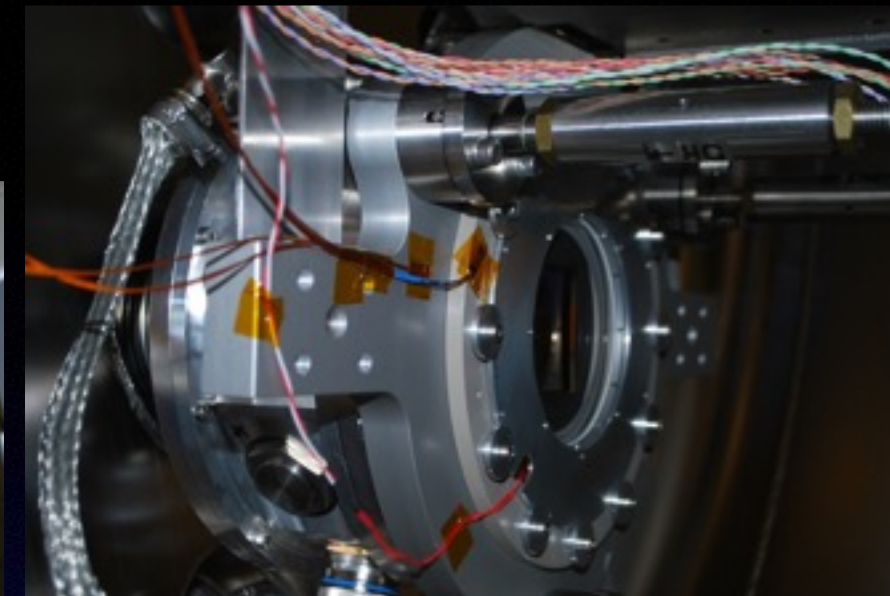
Detections in the global sample

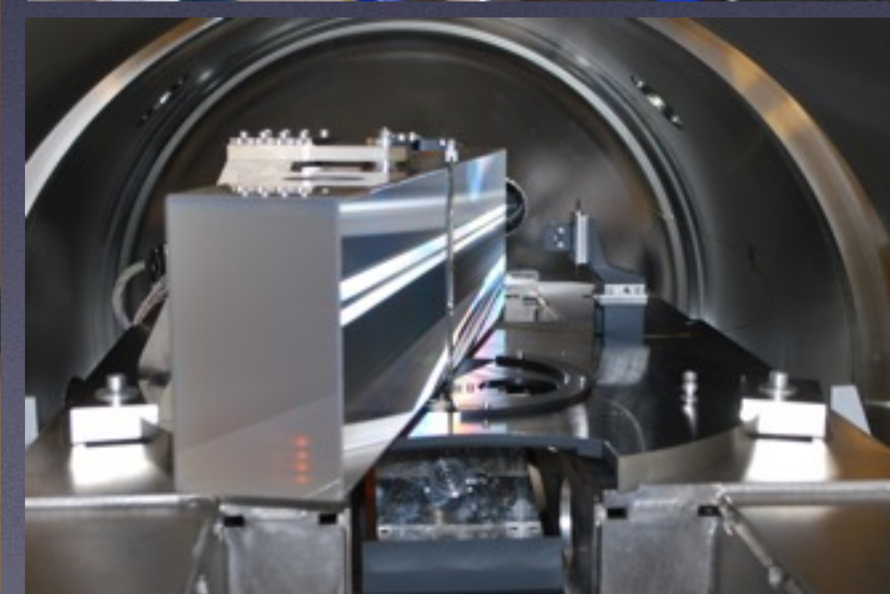


...and for P < 100 days



HARPS-N La Palma





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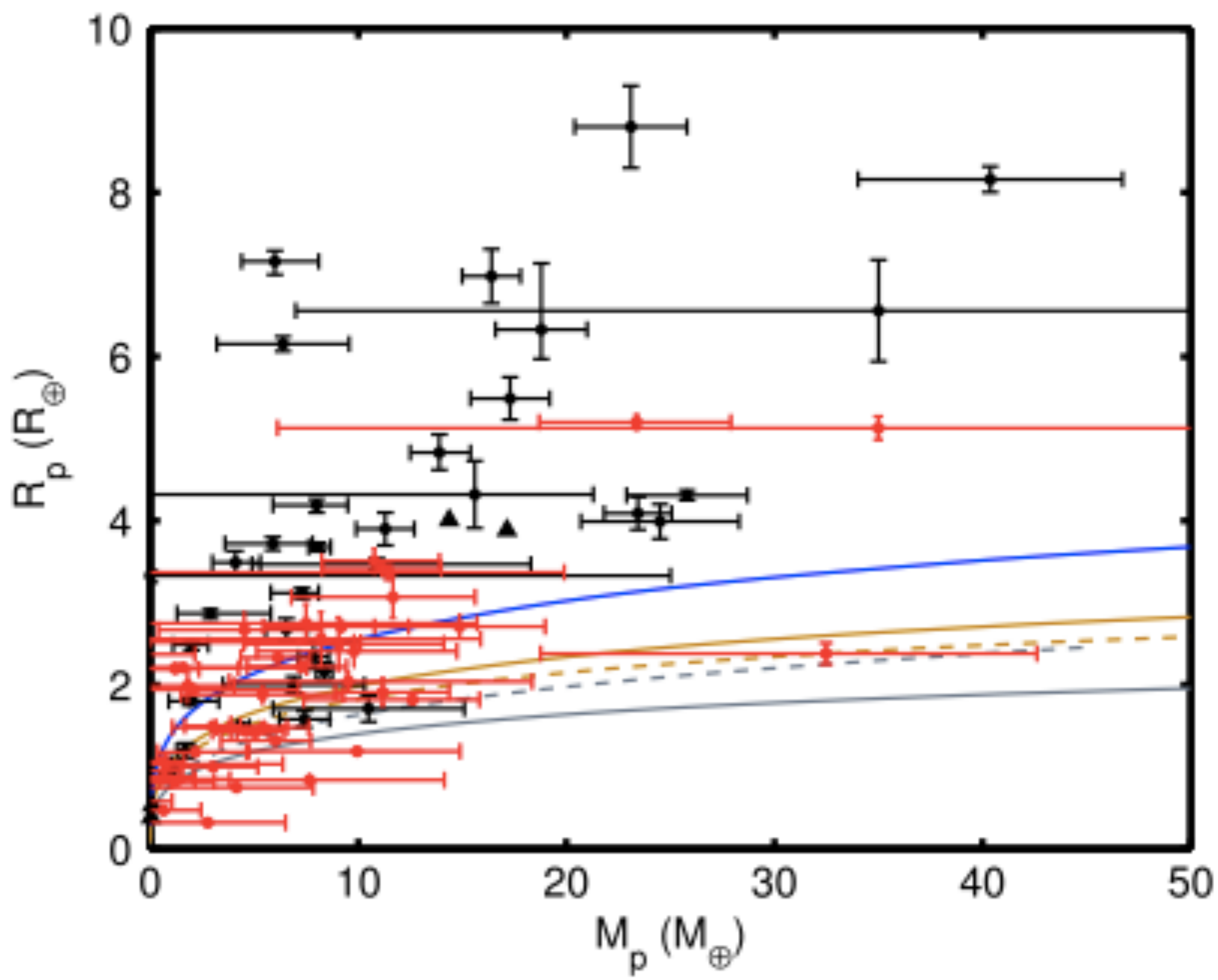
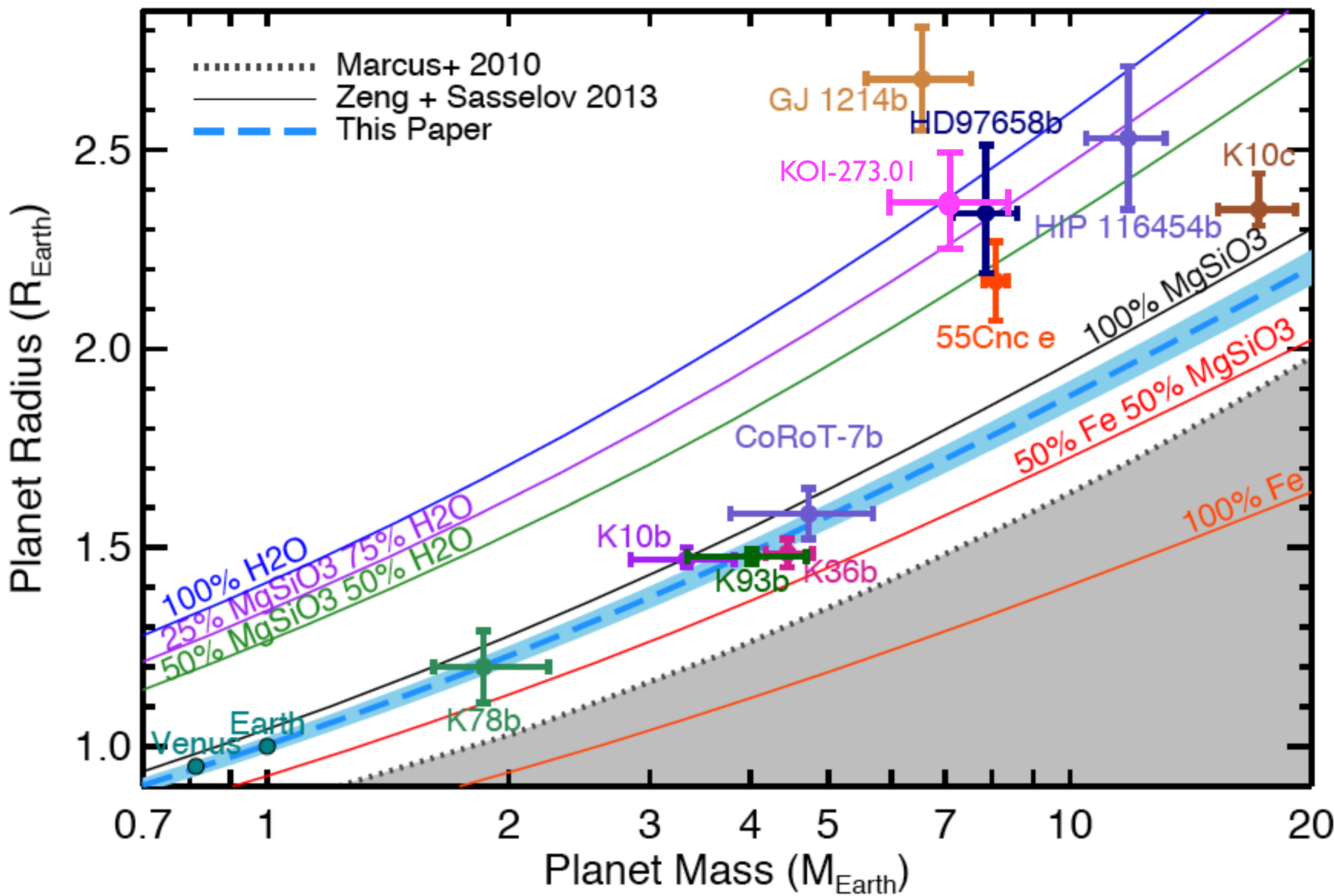


Figure 1. Planet mass–radius diagram. The sample of *Kepler* planets with RV follow-up used in this work are highlighted in red. Other confirmed transiting sub-Neptune-sized planets are indicated with black points, and the solar system planets are indicated with black triangles. The colored curves are theoretical mass–radius relations for constant planet compositions from Seager et al. (2007): pure water ice (solid blue), pure $MgSiO_3$ silicate (solid brown), Earth-like composition (32% Fe, 68% silicate, dashed brown), maximum-density limit for rocky planets from simulations of collisional stripping (Marcus et al. 2010, dashed gray) and pure Fe (solid gray).



Marcus+ 2010
Zeng + Sasselov 2013
This Paper
GJ 1214b
HD97658b
KOI-273.01
HIP 116454b
K10c
55Cnc e
100% MgSiO3
50% Fe 50% MgSiO3
100% Fe
CoRoT-7b
100% H2O
25% MgSiO3 75% H2O
50% MgSiO3 50% H2O
K10b
K93b
K36b
K78b
Venus
Earth
Planet Radius (R_{Earth})
Planet Mass (M_{Earth})
2.5
2.0
1.5
1.0
0.7
1
2
3
4
5
7
10
20